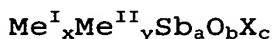


CLAIMS

1       1. A phosphor for converting ultraviolet light or blue  
2       light emitted from a light emitting element into a visible  
3       white radiation having a very high level of color rendering  
4       properties, said phosphor being characterized by comprising a  
5       light emitting component prepared from a solid system of an  
6       alkaline earth metal antimonate and a system derived from the  
7       solid system exhibiting intrinsic photoemission, such as a  
8       fluoroantimonate, a light emitting component prepared from a  
9       manganese(IV)-activated antimonate, a titanate, silicate-  
10      germanate, and an aluminate, a light emitting component  
11      prepared from a europium-activated silicate-germanate or from  
12      a system containing a sensitizer selected from a group  
13      consisting of Eu(II) and Mn(II) as a secondary activator and  
14      having an orange color, an orange-red color, a red color, or a  
15      dark red color in the spectrum range over 600 nm, or a light  
16      emitting component composed of a mixture of eight or less  
17      light emitting components having different emission bands and  
18      brought to a state of broad continuous emission of about 380  
19      to 780 nm having a color temperature of about 10,000 K with  
20      blue-white color to 6,500 K with daylight color and a color  
21      temperature of about 3,000 K with warm white color to 2,000 K  
22      with twilight color of reddish yellow by virtue of the  
23      superposition of the emission bands.

1       2. A phosphor for converting ultraviolet or blue light

2 emitted from the light emitting element according to claim 1 to  
3 a visible white radiation having a very high level of color  
4 rendering properties, characterized by comprising a light  
5 emitting alkaline earth metal antimonate represented by general  
6 formula



8 wherein

9  $Me^I$  is at least one element selected from the group  
10 consisting of calcium (Ca), strontium (Sr), barium (Ba),  
11 cadmium (Cd), zinc (Zn), beryllium (Be), magnesium (Mg),  
12 europium (Eu), manganese (Mn), scandium (Sc), yttrium (Y),  
13 lanthanum (La), samarium (Sm), praseodymium (Pr), dysprosium  
14 (Dy), and terbium (Tb),

15  $Me^{II}$  is at least one element selected from the group  
16 consisting of lithium (Li), sodium (Na), potassium (K),  
17 rubidium (Rb), and cesium (Cs),

18 X (uppercase letter) represents at least one element  
19 selected from the group consisting of fluorine (F), chlorine  
20 (Cl), and bromine (Br),

21 x (lowercase letter) = 0 (zero) to 8,

22 y = 0 to 4,

23 0 < a < 16,

24 0 < b < 64,

25 0 ≤ c ≤ 4,

26 and a part of antimony (Sb) may be replaced with vanadium  
27 (V), niobium (Nb), tantalum (Ta), phosphorus (P), arsenic (As),  
28 titanium (Ti), zirconium (Zr), hafnium (Hf), silicon (Si),  
29 germanium (Ge), molybdenum (Mo), or tungsten (W), or

30 alternatively may contain a system derived from them, for  
31 example, a fluoroantimonate.

1           3. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to claim 1 or  
3 2 to a visible white radiation having a very high level of  
4 color rendering properties, characterized by comprising an  
5 alkaline earth metal antimonate which exhibits intrinsic  
6 photoemission and emits light in a red spectrum region with a  
7 maximum emission wavelength of about 600 to 670 nm.

1           4. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to claim 1 or  
3 2 to a visible white radiation having a very high level of  
4 color rendering properties, characterized by comprising a light  
5 emitting manganese(IV)-activated antimonate which exhibits an  
6 emission band in a deep red spectrum region with about 600 to  
7 700 nm or a narrow structured light emission with about 650 to  
8 660 nm.

1           5. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to claim 1 to  
3 a visible white radiation having a very high level of color  
4 rendering properties, characterized by comprising a  
5 manganese(IV)-activated titanate represented by general formula  
6            $Me^I_x Me^{II}_y Ti_{1-a} O_4 X_m : Mn_z$   
7 wherein

8            $Me^I$  is at least one divalent cation selected from the

9 group consisting of Ca, Sr, Ba, Eu, Be, Mg, and Zn, or at least  
10 one trivalent cation selected from group III metals of the  
11 Periodic Table, for example, Sc, Y, and La and Gd, Sm, Dy, and  
12 Pr,

13  $Me^{II}$  is at least one monovalent cation selected from the  
14 group consisting of alkali metals,

15 X is an ion selected from Cl and F for charge balancing,

16  $0 \leq x \leq 4$ ,

17  $0 \leq y \leq 4$ ,

18  $0 \leq m \leq 4$ ,

19  $0 \leq a \leq 1$ , and

20  $0 < z \leq 0.5$ ,

21 Mn is manganese with a valence of 2 to 4 and incorporated  
22 into the lattice, and

23 Ti is titanium that may be completely or partially  
24 replaced with Zr, Hf, Si, or Ge, and may be partially replaced  
25 with B (boron), Al (aluminum), Ga (gallium), In (indium), P, Nb,  
26 Ta, or V, provided that, in this case, in the cation partial  
27 lattice, there is a proper charge balance or a halogen is  
28 further incorporated.

1 6. A phosphor for LED for converting ultraviolet or blue  
2 light emitted from the light emitting element according to  
3 claim 1 to a visible white radiation having a very high level  
4 of color rendering properties, characterized by comprising a  
5 red light emitting manganese(IV)-activated silicate-germanate  
6 or yellow-orange light emitting manganese(II)-activated  
7 silicate-germanate represented by general formula



9       wherein

10        $Me^I$  is at least one divalent or/and trivalent metal  
11       selected from group II or III metals of the Periodic Table  
12       and/or at least one lanthanide ion selected from the group  
13       consisting of Eu, Pr, Sm, Gd, and Dy,

14        $Me^{II}$  is at least one monovalent cation,

15       X is at least one anion selected from Cl and F elements,

16        $0 < w \leq 0.5$ ,

17        $0 < x \leq 28$ ,

18        $0 \leq y \leq 14$ ,

19        $0 \leq m \leq 20$ ,

20        $0 \leq a < 1$ ,

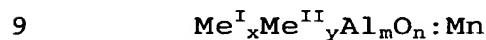
21        $0 < z \leq 48$ ,

22       and Ge may be completely or partially replaced with Si,  
23       Zr, or Ti, and/or may be partially replaced with B, Al, or Ga,  
24       and further may be replaced with P, V, Nb, Ta, W, or Mo.

1       7. A phosphor for converting ultraviolet or blue light  
2       emitted from the light emitting element according to claim 1 to  
3       a visible white radiation having a very high level of color  
4       rendering properties, characterized by comprising a europium-  
5       activated silicate-germanate capable of emitting a light among  
6       lights ranging from orange light to orange-red light with a  
7       broadband light emitting spectrum at 588 to 610 nm.

1       8. A phosphor for converting ultraviolet or blue light  
2       emitted from the light emitting element according to claim 1 to

3 a visible white radiation having a very high level of color  
4 rendering properties, characterized by comprising a red light  
5 emitting manganese(IV)-activated aluminate or orange light  
6 emitting manganese(II)-activated aluminate having a simple  
7 spinel-type structure up to a hexagonal structure represented  
8 by general formula



10 wherein

11  $Me^I$  is at least one element selected from group II or III  
12 metals of the Periodic Table and/or at least one lanthanide ion  
13 selected from the group consisting of Eu, Pr, Sm, Gd, Dy, and  
14 Ce,

15  $Me^{II}$  is at least one monovalent cation,

16  $0 \leq x \leq 8$ ,

17  $0 \leq y \leq 4$ ,

18  $0 < m \leq 16$ ,

19  $0 < n \leq 27$ ,

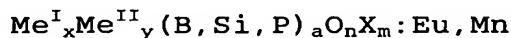
20  $0 < z \leq 0.5$ , and

21 Al may be completely or partially replaced with B and/or  
22 Ga and/or may be partially replaced with P, V, Nb, Ta, Si, Ge,  
23 W, or Mo.

1 9. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to any one of  
3 claims 1, 6 and 8 to a visible white radiation having a very  
4 high level of color rendering properties, characterized in that  
5 a europium-manganese double activated phosphor is contained and  
6 that light, emitted from a manganese(II) ion, in a color among

7 colors ranging from yellow to red colors as either a separate  
8 emission band or a shoulder in low wavelength fusion of primary  
9 light emission is sensitized with a primary activator in which  
10 the emission band overlaps with at least one characteristic  
11 excitation band of manganese(II) and emission of light from Eu  
12 is produced in a blue to green spectrum region.

1 10. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to claim 1 or  
3 9 to a visible white radiation having a very high level of  
4 color rendering properties, characterized by comprising a  
5 borate-silicate-phosphate which has been activated by europium  
6 and manganese and is represented by general formula



7 wherein

8  $\text{Me}^{\text{I}}$  is at least one element selected from group II and/or  
9 group III metals of the Periodic Table and/or at least one  
10 lanthanide ion selected from the group consisting of Eu, Pr, Sm,  
11 Gd, Dy, and Ce,  
12

13  $\text{Me}^{\text{II}}$  is at least one monovalent cation,

14  $\text{X}$  is Cl, F, or Br,

15  $0 \leq x \leq 10$ ,

16  $0 \leq y \leq 12$ ,

17  $0 < a \leq 6$ ,

18  $0 < n \leq 24$ ,

19  $0 \leq m \leq 16$ , and

20 B may be completely or partially replaced with P, Si, Ga,  
21 or Al and may be partially replaced with V, Nb, Ta, Ge, W, or

22 Mo.

1           11. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to any one of  
3 claims 1 to 10 to a visible white radiation having a very high  
4 level of color rendering properties, characterized in that  
5 white light having color rendering  $I_a$  and a color rendering  
6 index  $R_a > 90$  is produced by a combination of a radiation  
7 emitted from the phosphor with a primary radiation emitted from  
8 a light emitting element capable of constituting a  
9 semiconductor element or a gas discharge lamp and, thus, this  
10 element can be used as a background illumination device and in  
11 lighting in a living space and furnishings, in photography and  
12 microscopic examination, in medical technology, and in lighting  
13 technology in museums and any place where a very authentic  
14 color rendering is important.

1           12. A phosphor for converting ultraviolet or blue light  
2 emitted from the light emitting element according to any one of  
3 claims 1 to 11 to a visible white radiation having a very high  
4 level of color rendering properties, characterized in that said  
5 phosphor is applied, either solely or as a mixture of other  
6 phosphor, as a layer in a light emitting element and white  
7 light with color rendering  $I_a$  is produced by a combination of a  
8 primary radiation emitted from said light emitting element with  
9 a radiation emitted from the layer of the phosphor.

1           13. A phosphor for converting ultraviolet or blue light

2 emitted from the light emitting element according to any one of  
3 claims 1 to 12 to a visible white radiation having a very high  
4 level of color rendering properties, characterized in that said  
5 light emitting element used is LED for emitting a primary  
6 radiation in an ultraviolet spectrum region with more than 300  
7 nm or a violet or blue spectrum region with more than 380 nm.

1 14. An optical device comprising a wavelength converting  
2 part, said wavelength converting part comprising a phosphor  
3 capable of emitting light excited based on light emitted from  
4 an LED element, characterized in that

5 said wavelength converting part comprises a light  
6 emitting component prepared from a solid system of an alkaline  
7 earth metal antimonate and a system derived from the solid  
8 system exhibiting intrinsic photoemission, such as a  
9 fluoroantimonate, a light emitting component prepared from a  
10 manganese(IV)-activated antimonate, a titanate, silicate-  
11 germanate, and an aluminate, a light emitting component  
12 prepared from a europium-activated silicate-germanate or from a  
13 system containing a sensitizer selected from a group consisting  
14 of Eu(II) and Mn(II) as a secondary activator and having an  
15 orange color, an orange-red color, a red color, or a dark red  
16 color in the spectrum range over 600 nm, or a phosphor with a  
17 different emission band.

1 15. An optical device characterized by comprising  
2 an LED element,  
3 a power feeding part for mounting said LED element

4 thereon and feeding power to said LED element,

5 a light transparent sealing part for sealing said LED  
6 element and said power feeding part integrally with each other,  
7 and

8 a wavelength converting part for emitting light upon  
9 excitation based on light emitted from said LED element, said  
10 wavelength converting part comprising a light emitting  
11 component prepared from a solid system of an alkaline earth  
12 metal antimonate and a system derived from the solid system  
13 exhibiting intrinsic photoemission, such as a fluoroantimonate,  
14 a light emitting component prepared from a manganese(IV)-  
15 activated antimonate, a titanate, silicate-germanate, and an  
16 aluminate, a light emitting component prepared from a europium-  
17 activated silicate-germanate or from a system containing a  
18 sensitizer selected from a group consisting of Eu(II) and  
19 Mn(II) as a secondary activator and having an orange color, an  
20 orange-red color, a red color, or a dark red color in the  
21 spectrum range over 600 nm, or a phosphor with a different  
22 emission band.

1 16. An optical device characterized by comprising  
2 an LED lamp,

3 a light guiding part for guiding light emitted from said  
4 LED lamp,

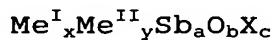
5 a wavelength converting part for emitting light upon  
6 excitation based on light guided through said light guiding  
7 part, said wavelength converting part comprising a light  
8 emitting component prepared from a solid system of an alkaline

9 earth metal antimonate and a system derived from the solid  
10 system exhibiting intrinsic photoemission, such as a  
11 fluoroantimonate, a light emitting component prepared from a  
12 manganese(IV)-activated antimonate, a titanate, silicate-  
13 germanate, and an aluminate, a light emitting component  
14 prepared from a europium-activated silicate-germanate or from a  
15 system containing a sensitizer selected from a group consisting  
16 of Eu(II) and Mn(II) as a secondary activator and having an  
17 orange color, an orange-red color, a red color, or a dark red  
18 color in the spectrum range over 600 nm, or a phosphor with a  
19 different emission band, and

20 a part to be lighted based on light emitted through said  
21 wavelength converting part.

1 17. An optical device according to any one of claims 14  
2 to 16, characterized in that

3 said wavelength converting part comprises a phosphor,  
4 said phosphor comprising a light emitting alkaline earth metal  
5 antimonate represented by general formula



6 wherein

7  $\text{Me}^{\text{I}}$  is at least one element selected from the group  
8 consisting of calcium (Ca), strontium (Sr), barium (Ba),  
9 cadmium (Cd), zinc (Zn), beryllium (Be), magnesium (Mg),  
10 europium (Eu), manganese (Mn), scandium (Sc), yttrium (Y),  
11 lanthanum (La), samarium (Sm), praseodymium (Pr), dysprosium  
12 (Dy), and terbium (Tb),

13  $\text{Me}^{\text{II}}$  is at least one element selected from the group

15 consisting of lithium (Li), sodium (Na), potassium (K),  
16 rubidium (Rb), and cesium (Cs),

17 X (uppercase letter) represents at least one element  
18 selected from the group consisting of fluorine (F), chlorine  
19 (Cl), and bromine (Br),

20 x (lowercase letter) = 0 (zero) to 8,

21 y = 0 to 4,

22 0 < a < 16,

23 0 < b < 64,

24 0 ≤ c ≤ 4,

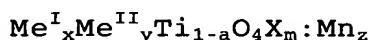
25 and a part of antimony (Sb) may be replaced with vanadium  
26 (V), niobium (Nb), tantalum (Ta), phosphorus (P), arsenic (As),  
27 titanium (Ti), zirconium (Zr), hafnium (Hf), silicon (Si),  
28 germanium (Ge), molybdenum (Mo), or tungsten (W), or  
29 alternatively may contain a system derived from them, for  
30 example, a fluoroantimonate.

1 18. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising an alkaline earth metal  
4 antimonate which exhibits intrinsic photoemission and emits  
5 light in a red spectrum region with a maximum emission  
6 wavelength of about 600 to 670 nm.

1 19. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising a light emitting manganese(IV)-  
4 activated antimonate which exhibits an emission band in a deep

5 red spectrum region with about 600 to 700 nm or a narrow  
6 structured light emission with about 650 to 660 nm.

1 20. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising a manganese(IV)-activated  
4 titanate represented by general formula



5 wherein

7  $\text{Me}^{\text{I}}$  is at least one divalent cation selected from the  
8 group consisting of Ca, Sr, Ba, Eu, Be, Mg, and Zn, or at least  
9 one trivalent cation selected from group III metals of the  
10 Periodic Table, for example, Sc, Y, and La and Gd, Sm, Dy, and  
11 Pr,

12  $\text{Me}^{\text{II}}$  is at least one monovalent cation selected from the  
13 group consisting of alkali metals,

14 X is an ion selected from Cl and F for charge balancing,

15  $0 \leq x \leq 4$ ,

16  $0 \leq y \leq 4$ ,

17  $0 \leq m \leq 4$ ,

18  $0 \leq a \leq 1$ , and

19  $0 \leq z \leq 0.5$ ,

20 Mn is manganese with a valence of 2 to 4 and incorporated  
21 into the lattice, and

22 Ti is titanium that may be completely or partially  
23 replaced with Zr, Hf, Si, or Ge, and may be partially replaced  
24 with B (boron), Al (aluminum), Ga (gallium), In (indium), P, Nb,  
25 Ta, or V, provided that, in this case, in the cation partial

26 lattice, there is a proper charge balance or a halogen is  
27 further incorporated.

1           21. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising a red light emitting  
4 manganese(IV)-activated silicate-germanate or yellow-orange  
5 light emitting manganese(II)-activated silicate-germanate  
6 represented by general formula



7           wherein

9           Me<sup>I</sup> is at least one divalent or/and trivalent metal  
10 selected from group II or III metals of the Periodic Table  
11 and/or at least one lanthanide ion selected from the group  
12 consisting of Eu, Pr, Sm, Gd, and Dy,

13           Me<sup>II</sup> is at least one monovalent cation,

14           X is at least one anion selected from Cl and F elements,

15           0 ≤ w ≤ 0.5,

16           0 < x ≤ 28,

17           0 ≤ y ≤ 14,

18           0 ≤ m ≤ 20,

19           0 ≤ a < 1,

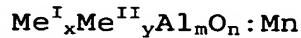
20           0 < z ≤ 48,

21           and Ge may be completely or partially replaced with Si,  
22 Zr, or Ti, and/or may be partially replaced with B, Al, or Ga,  
23 and further may be replaced with P, V, Nb, Ta, W, or Mo.

1           22. The optical device according to any one of claims 14

2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising a europium-activated silicate-  
4 germanate capable of emitting a light among lights ranging from  
5 orange light to orange-red light with a broadband light  
6 emitting spectrum at 588 to 610 nm.

1 23. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part  
3 comprises a phosphor comprising a red light emitting  
4 manganese(IV)-activated aluminate or orange light emitting  
5 manganese(II)-activated aluminate having a simple spinel-type  
6 structure up to a hexagonal structure represented by general  
7 formula



9 wherein

10  $\text{Me}^{\text{I}}$  is at least one element selected from group II or III  
11 metals of the Periodic Table and/or at least one lanthanide ion  
12 selected from the group consisting of Eu, Pr, Sm, Gd, Dy, and  
13 Ce,

14  $\text{Me}^{\text{II}}$  is at least one monovalent cation,

15  $0 \leq x \leq 8$ ,

16  $0 \leq y \leq 4$ ,

17  $0 < m \leq 16$ ,

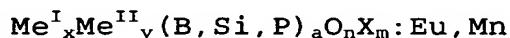
18  $0 < n \leq 27$ ,

19  $0 < z \leq 0.5$ ,

20 Al may be completely or partially replaced with B and/or  
21 Ga and/or may be partially replaced with P, V, Nb, Ta, Si, Ge,  
22 W, or Mo.

1        24. The optical device according to any one of claims 14  
2        to 16, characterized in that said wavelength converting part  
3        comprises a europium-manganese double activated phosphor and  
4        that light, emitted from a manganese(II) ion, in a color among  
5        colors ranging from yellow to red colors as either a separate  
6        emission band or a shoulder in low wavelength fusion of primary  
7        light emission is sensitized with a primary activator in which  
8        the emission band overlaps with at least one characteristic  
9        excitation band of manganese(II) and emission of light from Eu  
10      is produced in a blue to green spectrum region.

1        25. The optical device according to any one of claims 14  
2        to 16, characterized in that said wavelength converting part  
3        comprises a phosphor comprising a borate-silicate-phosphate  
4        which has been activated by europium and manganese and is  
5        represented by general formula



7        wherein

8         $\text{Me}^{\text{I}}$  is at least one element selected from group II and/or  
9        group III metals of the Periodic Table and/or at least one  
10      lanthanide ion selected from the group consisting of Eu, Pr, Sm,  
11      Gd, Dy, and Ce,

12       $\text{Me}^{\text{II}}$  is at least one monovalent cation,

13      X is Cl, F, or Br,

14       $0 \leq x \leq 10$ ,

15       $0 \leq y \leq 12$ ,

16       $0 < a \leq 6$ ,

17           0 < n ≤ 24,

18           0 ≤ m ≤ 16, and

19           B may be completely or partially replaced with P, Si, Ga,  
20 or Al and may be partially replaced with V, Nb, Ta, Ge, W, or  
21 Mo.

1           26. The optical device according to claim 15,  
2 characterized in that said wavelength converting part is  
3 included in said light transparent sealing resin for sealing  
4 said LED element.

1           27 The optical device according to claim 15,  
2 characterized in that said phosphor is a thin-film phosphor  
3 layer that is sealed with said light transparent glass.

1           28. The optical device according to claim 26,  
2 characterized in that said phosphor layer is planar.

1           29. The optical device according to claim 15,  
2 characterized in that said wavelength converting part is  
3 provided on a surface of the sealing resin having an optical  
4 shape that radiates light emitted from said LED element in a  
5 desired lighting area.

1           30. The optical device according to any one of claims 14  
2 to 16, characterized in that said wavelength converting part is  
3 excited upon exposure to blue light and/or ultraviolet light  
4 with wavelengths ranging from 300 nm to 500 nm.